

What is claimed is:

- 1 1. A direct frequency synthesizer, comprising:
 - 2 a first frequency division path dividing an applied reference signal by a first divisor to
 - 3 provide a first signal;
 - 4 a second frequency division path dividing the reference signal by a second divisor to
 - 5 provide a second signal and dividing the second signal by a third divisor to provide a third signal,
 - 6 the second frequency division path having a mixer receiving the second signal and the third
 - 7 signal; and
 - 8 an output mixer receiving the first signal and a product of the second signal and the third
 - 9 signal, and providing an output signal having a frequency relationship to the applied reference
 - 10 signal.
- 1 2. The direct frequency synthesizer of claim 1 wherein the output signal has a frequency of a designated mixing product of the second signal and the third signal, offset in frequency by the frequency of the first signal.
- 1 3. The direct frequency synthesizer of claim 1 further comprising an offset loop synthesizer receiving the output signal.
- 1 4. The direct frequency synthesizer of claim 2 further comprising an offset loop synthesizer receiving the output signal.

1 5. The direct frequency synthesizer of claim 3 wherein the offset loop synthesizer
2 provides a first local oscillator signal for a spectrum analyzer.

1 6. The direct frequency synthesizer of claim 5 wherein the first local oscillator signal has
2 a frequency equal to a harmonic multiple of the frequency of the output signal, offset in
3 frequency by an interpolation signal in the offset loop synthesizer.

1 7. The direct frequency synthesizer of claim 5 wherein the reference signal is provided
2 by a second local oscillator of the spectrum analyzer.

1 8. The direct frequency synthesizer of claim 1 wherein the first frequency division path
2 includes a programmable frequency divider and fixed frequency divider cascaded with the
3 programmable frequency divider providing the first signal.

1 9. The direct frequency synthesizer of claim 1 wherein the second frequency division
2 path includes a first frequency divider having a fixed divisor and providing the second signal, and
3 a second frequency divider having alternative divisor settings and providing the third signal.

1 10. The direct frequency synthesizer of claim 8 wherein the second frequency division
2 path includes a first frequency divider having a fixed divisor and providing the second signal, and
3 a second frequency divider having alternative divisor settings and providing the third signal.

1 11. The direct frequency synthesizer of claim 1 further comprising a filter selecting the
2 output signal from a series of mixing products provided by the output mixer.

1 12. The direct frequency synthesizer of claim 5 wherein the offset loop synthesizer
2 includes a harmonic mixer receiving the output signal and the first local oscillator signal and
3 providing a mixing product to a frequency/phase detector that compares the mixing product with
4 an interpolation signal to control a tuneable oscillator that provides the first local oscillator
5 signal.

1 13. A direct frequency synthesizer, comprising:
2 a first frequency division path dividing an applied reference signal by a first divisor to
3 provide a first signal;
4 a second frequency division path dividing the reference signal by a second divisor to
5 provide a second signal and further dividing the second divided signal by a third divisor to
6 provide a third signal, the second frequency division path having a mixer receiving the second
7 signal and the third signal;
8 an output mixer receiving the first signal and a product of the second signal and the third
9 signal, providing a first output signal having a frequency relationship to the applied reference
10 signal; and
11 an offset loop synthesizer receiving the first output signal and providing a second output
12 signal related in frequency to the first output signal and an interpolation signal within the offset
13 loop synthesizer.

1 14. The direct frequency synthesizer of claim 13 wherein the reference signal is provided
2 by a second local oscillator of a spectrum analyzer and the second output signal provides a first
3 local oscillator signal in the spectrum analyzer.

1 15. The direct frequency synthesizer of claim 13 wherein the second output signal is a
2 harmonic multiple of the first output signal offset by the interpolation signal.

1 16. The direct frequency synthesizer of claim 15 wherein the first output signal has a
2 frequency of a designated mixing product of the second signal and the third signal, offset in
3 frequency by the frequency of the first signal.

1 17. A direct frequency synthesis method, comprising:
2 dividing an applied reference signal by a first divisor to provide a first signal;
3 dividing the reference signal by a second divisor to provide a second signal;
4 dividing the second signal by a third divisor to provide a third signal;
5 mixing the second signal and the third signal; and
6 mixing a designated product of the second signal and the third signal with the first signal
7 to provide an output signal related in frequency to the applied reference signal.

1 18. The direct frequency synthesis method of claim 17 further comprising applying the
2 output signal to an offset loop synthesizer.

1 19. The direct frequency synthesis method of claim 18 wherein the offset loop
2 synthesizer provides a first local oscillator signal for a spectrum analyzer.

1 20. The direct frequency synthesis method of claim 19 wherein the reference signal is
2 provided by a second local oscillator signal of the spectrum analyzer.